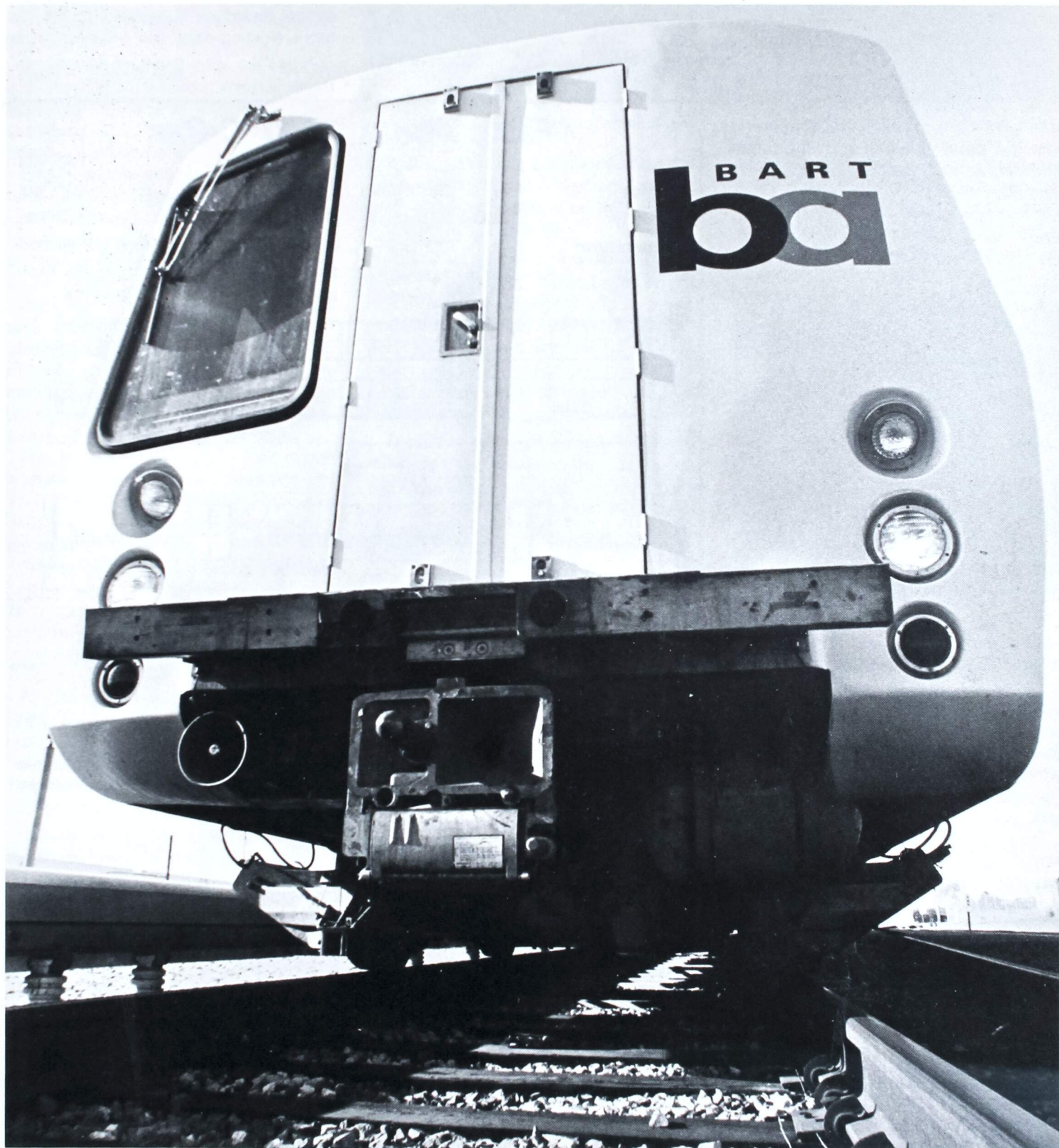




In Service Early 1988

C-CAR — A NEW GENERATION OF BART CARS

BART ACQUIRING 150 NEW CARS TO MEET ANTICIPATED PATRONAGE

In the spring of 1979, almost seven years after the beginning of revenue service, BART took a long and thorough look at the need for expanding its passenger-carrying capacity.

The need for expansion was obvious, both to improve service to current passengers and to meet the demands of increasing patronage.

The District's patronage totaled 41,191,566 passenger miles in the fiscal year 1978-1979, up almost 6.5 percent from the previous year and forecasts predicted an increase in patronage of 28 percent by 1985.

At that time, BART's fleet of passenger cars consisted of 137 sloping-front lead cars, designated "A-cars," and 303 mid-train "B-cars."



BART TRAINS . . . the C-Car is on the middle track in downtown Oakland.

A decision to acquire additional cars was interlocked with several other related actions, such as expanding storage and turnback facilities, increasing electrical capacity, improving wayside train control, constructing additional trackage under downtown Oakland, upgrading on-board automatic train control and improving the fire-resistant capabilities of all existing cars.

Thus, the story of the new C-car is a key part of the story of BART's overall capacity expansion program to meet the demands of increased ridership well into the future.

The responsibility for acquiring additional passenger-carrying capacity was handed to Richard P. Demko, Executive Manager for Maintenance and Engineering. He assembled and supervised a team, headed by Krishna V. Hari, to carry out all aspects of designing, bidding, manufacture, testing and delivery of the new cars. Other members of this "core" team were Maurice Clapp, Charles E. Jenkins, Jr., James H. King, Jr., James R. La Guardia, Robert W. Mix and George Wells.

Demko was convinced that BART engineers could design the C-car and was determined that the new car would be designed to provide more flexibility in daily train operations. He also insisted that com-

ponents that had proved reliable in the A and B cars were to be retained in the design of the C-car.

Demko's philosophy of "If it works, let's keep it" resulted in the retention of 28 components in the C-car from the A and B cars, cutting design risks and building in a measure of reliability, as well as eliminating the need to acquire an inventory of all new spare parts.

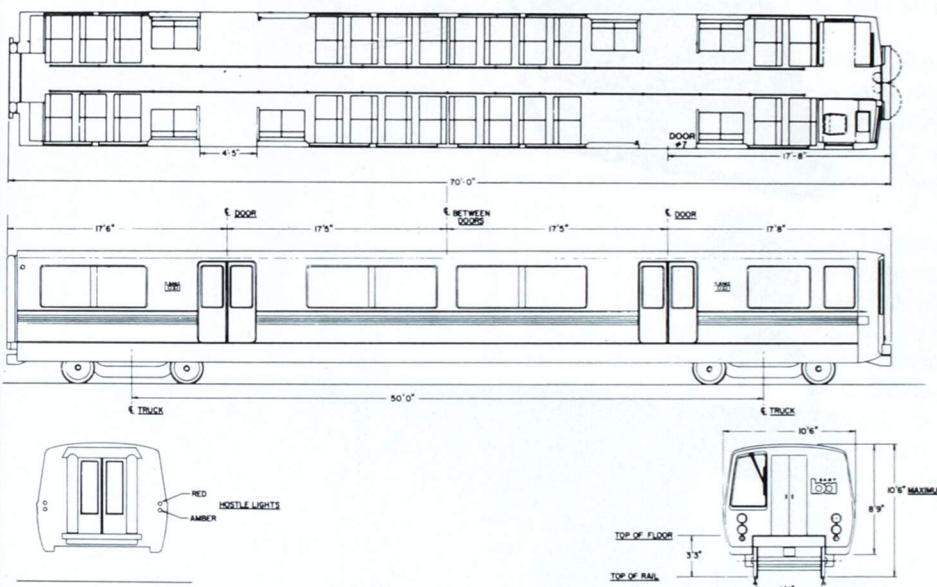
The committee recommended in July, 1979, that the District should acquire a C-car, a powered vehicle configuration to serve as a lead car or in the middle of a train.

The committee did not recommend any radical departure in design from the District's existing cars, but it called for the

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Facts About BART C-Car

Length:	70 feet	Width:	10.5 feet
Weight:	63,000 lbs.	Height:	10.5 feet
Humidity:	Below 60 percent	Ceiling Height:	6.75 feet
Temperature:	72°F (±3°F)	Acceleration:	3 mph per second
Seating:	64 (52 transverse + 12 longitudinal)	Speed:	80 mph maximum; 36 mph average with 20-sec. station stops.



Exterior: Brushed aluminum finish with blue striping and BART insignia.

Seats: Seats are cantilevered to offer maximum leg and luggage space, and to provide for ease of maintenance. Seat cushions are made of fire-resistant, low-smoke neoprene with covers made of 90 percent wool and 10 percent nylon.

Floors: Wall-to-wall, rust-colored, 100 percent wool carpeting. Wide, 30-inch aisles.

Windows: Panoramic View. Tinted and heat reflecting glass. The operator cab windshield is a high-impact glass.

Communication: VHF two-way radio telephone in cab. Announcements to cars can be made by Central Control at BART headquarters or by the train operator. Intercoms to allow passengers to call the operator are located at each end of the car.

Lighting: Recessed overhead fixtures provide both diffuse and high-intensity lighting for reading.

Propulsion: Four 150-HP, air-cooled electric, traction motors — one per axle. Tractive energy is furnished via the third rail operating at 1000 V DC. Tractive effort, DC propulsion and braking is controlled by a power semiconductor. A hydraulic disc brake system operating on each axle controls mechanical braking which is automatically blended with the electric brake system. Each car is equipped with an auxiliary electrical system operating at 120/208V AC 50Hz, supplied by a static inverter. Battery and battery chargers provide emergency power for lights, communication and control equipment.

Handrails: The ceiling hand rails extend the entire length of the car. Two "grab rails" are installed near two of the car's four doors.

elimination of the sloping front, which had seemed visually exciting in concept, but had proved to be inflexible in operation since the sloping-front A-cars could not be inserted into the middle of a train.

In fact, the new C-cars were to be essentially the same as the existing A-cars, with better automatic train control (ATC), fire-retardation, electric supply and friction brakes. Trucks, propulsion motors and couplers duplicate those on the A and B cars.

The committee suggested the acquisition of 90 new cars and the option to purchase an additional 60 cars, depending on need and the availability of funds to pay for them.

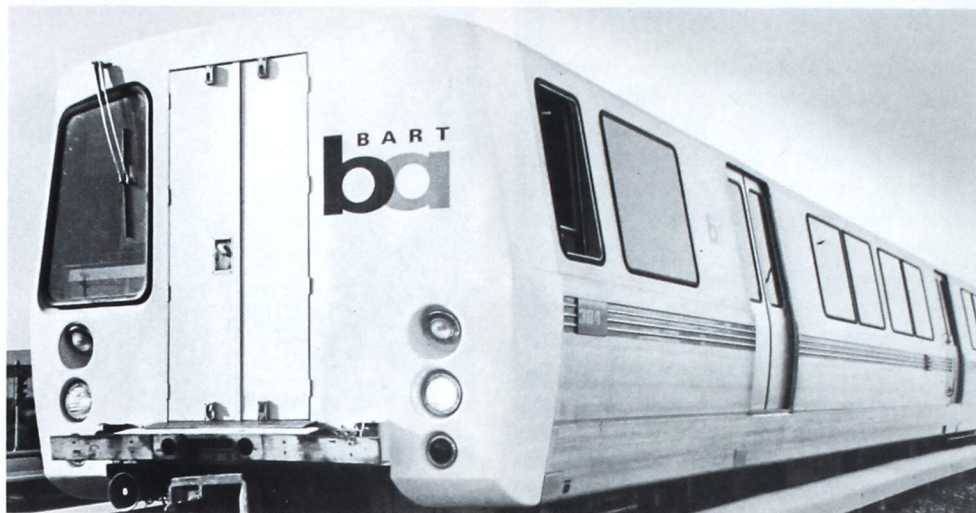
It was already recognized by BART, before plans were under way to acquire new cars, the existing ATC system was unreliable and that an improved system had to be developed for the A-cars.



Richard P. Demko, Exec. Mgr.
Maintenance & Engineering

BART's original cars, which were ordered in 1968 from Rohr Industries, Inc., cost approximately \$266,800 apiece for the first 250, \$370,000 for the next 100 and \$390,000 for the final 100.

By the time the C-car committee presented its recommendations to BART's Board of directors in October, 1979, it was estimated that the new cars would cost approximately \$1.2 million apiece. It was also estimated that it would take up to five



BART's new C-Car will cost less than the original bid price.

years for their design, construction, testing, evaluation and final delivery.

BART's Board had approved the broad outlines of the capacity expansion program and in July, 1980, following a recommendation from its Engineering and Operations committee, the directors voted to apply to the Urban Mass Transportation Administration (UMTA) for a grant of \$118.1 million to fund 80 percent of the cost of 90 new C-cars.

Later, following further studies that considered the funds available and weighed the probabilities of even higher costs in the future, BART's directors adopted a staff

recommendation to acquire 150 cars. That decision brought the total price tag to an estimated \$279.4 million, including escalation of prices due to inflation, contingencies and the automatic train control system. As it turned out, due to a lower rate of inflation than expected, stringent internal controls and no cost overruns — due to BART's tightly written and toughly enforced contracts — the cost of the C-cars is estimated at \$228,298,000.

In October, 1981, UMTA granted \$6.7 million for the acquisition of four prototype C-cars for rigorous testing and evaluation

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C-Car Management Team Does Outstanding Job

Krishna V. Hari, "point man" for BART's C-car, beams with pride when he talks about overall direction and the team of

BART specialists that contributed to the projects.

"It starts with Dick Demko," Hari says, referring to BART's Executive Manager of Maintenance and Engineering. "We felt his guiding hand and direction right from the first, plus his support, all the way, and he made sure that things went right. He has the overall perspective," Hari notes.

The team includes Maurice F. Clapp, David L. Johnston, James R. LaGuardia and Arnold Huberman.

Prototype testing-maintenance includes Raymond C. Crist, R.J. Grimes, Jr., Raymond S. Kawamoto, Harold R. Hacker, Jr., Joseph S. Grosser, Howard Blake, Kevin J. Reilly and Jorge F. Madrigal.

In France, Charles E. Jenkins, Jr., current resident engineer, George R. Wells, former resident engineer, Grant Tanner and John Burton.

In England, where the motors are manufactured, Gregory Graham, Darrel Benner, Mitchell Morris, George Ross, Richard King, Ken Gregory and Jim Easley.

In Union City, where the cars are assembled, Jim McDaniel, Ken Perez, Richard Ting, Ken Gregory and Dave Bowman, and in Pittsburg, where the air-conditioning units are built, Jorge Madrigal. **b**



The C-Car management team poses with a model of the new car. Shown left to right (front row) are: Maurice Clapp, Marion Dewies, Kris Hari; (back row) Jim LaGuardia, Arnold Huberman, George Wells and Dave Johnston.

prior to production of the entire new fleet. Nearly a year later, in September, 1982, BART sold \$65 million in sales tax revenue bonds to help pay for the fleet, and a month later UMTA committed an additional \$130 million. (Actually, because of the lower costs than expected of the C-cars and the related ATC, UMTA's total funding was \$113,005,000. The State provided \$28,527,000, bridge tolls contributed \$1,431,000 and the receipts from the revenue bonds plus BART reserves added \$85,335,000.)

In the meantime, BART had requested and received bids for the new cars from manufacturers in the United States and abroad. Between the time that BART ordered its first cars in the 1960s and the request for bids on its new cars, American manufacturers of aluminum railroad cars had virtually abandoned the field.

The contract was awarded in October, 1982, to SOFERVAL (Societe Ferroviaire du Valenciennois) a subsidiary of Alstom-Atlantique. The base bid was \$183.7 million, the largest contract ever awarded by BART. (The largest up until then was \$180 million — in 1970 dollars — for the Transbay Tube between Oakland and San Francisco.)

Although the contract was awarded to a French company, BART has estimated that 65 percent of the components would be supplied by American manufacturers. The contract stipulated that final assembly of the cars would take place in the United States.

(SOFERVAL's plant in France is in Raismes, near the Belgian border, and the company acquired the former Soule Steel Co. property in Union City, close to BART's main yard in Hayward, for final assembly of the C-cars.)

The contract with SOFERVAL set strict standards of quality, compliance, accountability and acceptance to meet BART's goals for reliability, maintainability, safety and human factors. Hari was named project director, backed up by a team of engineers that worked at BART's headquarters and in France. (BART engineers were also

assigned to Preston, England, where the traction motors were built, and to the locations of American manufacturers.)

Early in 1984, BART rejected four prototype cars because they failed to meet aesthetic standards: the prototypes' aluminum outer shell lacked the brush finish of other BART cars and, with noticeable indentations on the shell, failed to meet a "flatness test."

Though rejected for their poor aesthetic qualities, the cars were allowed to be delivered for the sole purpose of having their subsystems tested on the District's test track at Hayward Yard and on the main line. Following the series of tests, the cars were removed from District property and returned to SOFERVAL.

Testing of the conditionally-acceptable

cars by SOFERVAL and BART took a year, utilizing weekends and non-peak hours. "The whole program required long hours, hard work and repeated testing," Demko says, "but it will pay off."

The first contract-acceptable cars will soon begin to emerge from SOFERVAL's assembly plant in Union City. A "first article" configuration inspection assured BART that the car conformed to the configuration requirements of the contract. The delivery schedule calls for one car in November, four in December, six in January and from eight to nine a month thereafter.

"We're about 24 months behind in our delivery schedule, but we preferred to take a delay rather than compromise on our specifications," Demko says. **b**

C-Car to Get Top Maintenance

Making sure that the new C-cars dovetail neatly into BART's long-established preventive maintenance program is the job of Fred L. Stephens, in charge of rolling stock maintenance, and George H. Mackin, maintenance support.

Although the new cars look similar to the A and B cars at a glance, there are important structural and component differences that will affect C-car maintenance.

The bodies of the new cars are welded, not riveted, and component differences include the air-conditioning system, propulsion and the auxiliary power supply. Wheels, gear boxes and trucks on the new cars are the same as on the A and B cars.

BART's current cars are on a 500-hour preventive maintenance schedule, based on approximately 15 hours of passenger service per day. The C-cars are designed for 600 hours of revenue service between scheduled maintenance.

Acquiring more cars and putting them into service, however, doesn't necessarily translate into more maintenance activity. Car hours in service are what determines maintenance. With more cars in service, the planned number of service hours will be spread over a larger fleet.

"Preventive maintenance is a major part of our philosophy," Mackin explains. "At

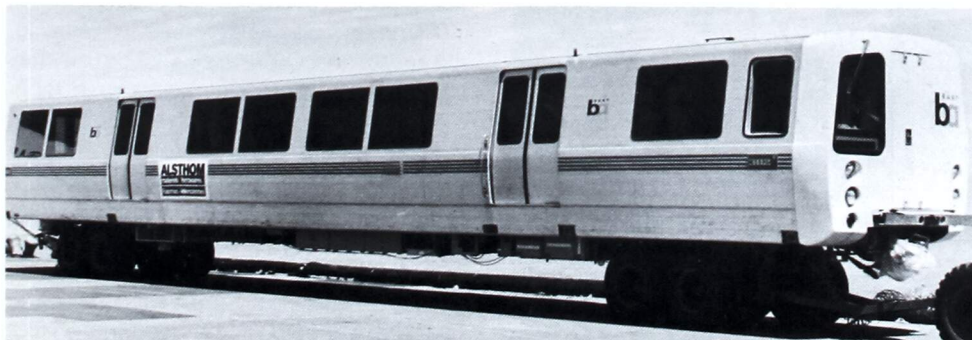
BART there is no such thing as deferred maintenance."

Another part of BART's maintenance philosophy, according to Stephens, is the strong practice of coordination between maintenance and vehicle engineering. "That will continue with the new cars," he says.

A major difference between the new cars and the present A and B cars, as far as maintenance is concerned, is that BART won't be involved in what Mackin calls "reverse engineering."

He explains that, from the inception of the C-car, BART has insisted on complete documentation from all manufacturers, access to plans, production and assembly and adherence to strict standards for both the car and its components. BART's maintenance team won't have to rework production drawings and diagrams. Those will already be at hand.

Actual maintenance experience can also lead to improvements in the car and its components. "Our documented results will be fed back to engineering for refinement and improvement," Stephens notes. **b**



C-Car arrives on rubber tires at Union City Plant.



First C-Car arrives in SF by boat.

PLANS SET TO PUT NEW CARS INTO SERVICE

When the question is, "How will the new cars be put into service?" the man with the answer is William B. Fleisher, BART's Chief Transportation Officer.

"The answer is — slowly and carefully," Fleisher says, and he added, sounding almost like a winemaker, "We will take our time."

In introducing the C-cars into the system, Fleisher explains, "We will move deliberately because we want to make sure everything works before we put the new cars in rush hour service."

BART's staff is committed to introducing the C-cars in a manner that does not disrupt the present hard-won reliability of peak-hour service. "That's Board policy — and staff-policy — and we intend to carry it out," Fleisher says.

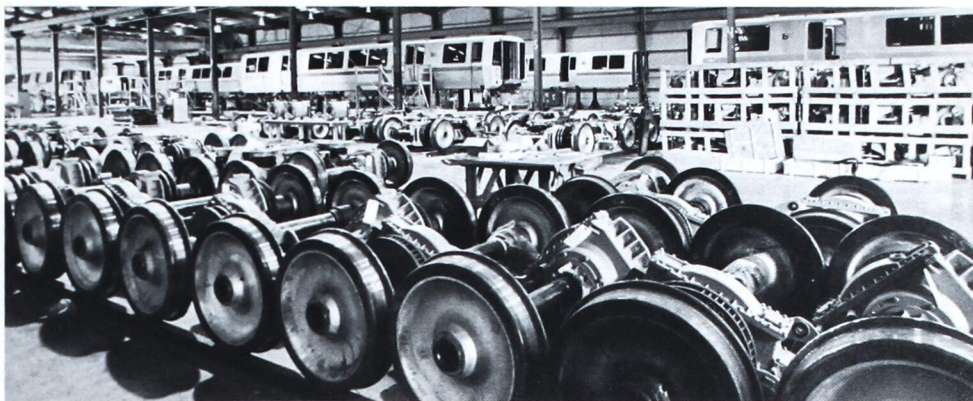
Planning for the use of new cars goes back to the first studies and decisions regarding their acquisition. "We came up with a plan that detailed how we'd actually introduce and use the cars and we decided right then that we wouldn't try to do everything at once," he explains.

The plan includes training operators, breaking in the production cars and the development of a complete logistics plan for gradually introducing cars into passenger service.

"We've been careful with this new car," Fleisher says. "We haven't downgraded passenger comfort or passenger safety — quite the opposite — and we've not compromised on correcting deficiencies in the prototypes."

At first, the cars will be put into non-passenger service from Hayward Yard and each of them will be operated for approximately 750 miles — about a week of running and evaluation.

Then they'll be inserted into night



Truck assemblies await installation at Union City.

Three main reasons supported the decision of BART's board of directors, following staff recommendations, to acquire 150 new cars for the system.

First of all, the new cars would add to BART's capacity to provide better service to its current passengers and to attract additional passengers. Additional passenger capacity would also enable BART to expand its service to communities not at present linked by rail to the existing 71.5-mile system.

A second reason was flexibility in the make-up of trains during the day to meet the requirements of peak service in the morning and evening. Under the present arrangement, with only A and B cars, all trains must be sent to a yard for breaking up into smaller units or for combining into longer trains.

An A-war cannot be positioned into the

middle of a string of B cars to form a shorter train except at one of BART's three yards located Hayward, Richmond and Concord. "With the new cars, we'll be able to add or subtract cars in the middle of a train without having to go into a yard," says William B. Fleisher, BART's Chief Transportation Officer.

A third major reason for acquiring the new cars was to save money on overall fleet operations. "We'll save money on power and on preventive maintenance, particularly when the Daly City Turnback and yard and shop facilities are in use," Fleisher notes. At present, it costs about 55 cents just in power alone to move a car one mile, according to Fleisher. The additional cars and the flexibility in making and breaking trains — provided by the additional storage, turnback and shop facilities — will eliminate the need for "deadhead" runs. **b**

passenger service from the Richmond yard. "At night, of course, the trains run less frequently. They're farther apart. If we have a problem, it'll be easier to deal with it without disrupting service," Fleisher points out.

The final phase of the initial passenger service will include running the new cars from Richmond during the night and in the middle of the day.

After the third week, if all goes well, the new cars will be scheduled for unlimited passenger service. They will be used as lead cars or inserted into trains made up of other cars.

After the introduction of the forty-ninth production C-car, the new cars will be utilized for making and breaking trains originating from the Richmond yard, thus making use of their full capability for the first time.

Richmond was selected as the initial location for the C-car trains because they can be dispatched directly from the Richmond yard into passenger service, making it easier to take care of problems without disrupting passenger service.

As the number of fully operational C-cars builds up at Richmond, A and B cars will be transferred to other yards so that all passengers will benefit from the new cars. Eventually C-cars will be used throughout the system. **b**



To provide space for wheelchairs, one of the side seats shown above has been removed from the C-Car.